

Food Plants and Life Histories of Sawflies of the Families Tenthredinidae and Pergidae (Hymenoptera) in Costa Rica, with Descriptions of Four New Species

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Abstract.—Food plants and biological information are given for five species of Tenthredinidae and six species of Pergidae reared in the Area de Conservación Guanacaste, Guanacaste Province, northwestern Costa Rica. The Tenthredinidae are *Adiaclema chigiyae* Smith, n. sp. on *Entodontopsis leucostega* (Stereophyllaceae), *Waldheimia fascipennis* (Norton) on *Cissus pseudosicyoides* (Vitaceae), *Waldheimia suturalis* (Cameron) on *Cissus rhombifolia* (Vitaceae), *Waldheimia interstitialis* (Cameron), n. comb., on *Hamelia patens* (Rubiaceae), and *Pristiphora auricauda* Smith on *Prunus annularis* (Rosaceae). The Pergidae are *Aulacomerus daktus* Smith on *Mesechites trifida* (Apocynaceae), *Anathulea bimaculata* (Cameron) on *Hippocratea volubilis* (Hippocrateaceae), *Suwatnus nigriceps* (Cameron) on *Psidium guajava* (Myrtaceae), *Acordulecera binelli* Smith, n. sp., on *Posoqueria latifolia* (Rubiaceae), *Acordulecera liami* Smith, n. sp., on *Erythroxylum havanense* (Erythroxylaceae), and *Acordulecera dashielli* Smith, n. sp., on *Arrabidaea patellifera* (Bignoniaceae). Several hundred wild-caught larvae of these 11 species produced no parasitoids. Redescriptions are given for *Aulacomerus daktus*, *Anathulea bimaculata*, and *Suwatnus nigriceps*.

This is the second of two treatments of the host plants and life histories of sawflies reared by DHJ during the Lepidoptera caterpillar inventory of the Area de Conservación Guanacaste (ACG), which lies primarily in Guanacaste Province in northwestern Costa Rica. The first covered the family Argidae (Smith and Janzen 2003). Here we consider the families Tenthredinidae and Pergidae, the adults of which may be distinguished in the key to families by Smith (1988, 1995). Symphyta larvae are keyed to family and to subfamilies within the Tenthredinidae by Smith and Middlekauff (1987). Though based on the Nearctic fauna, this larval key will be helpful for larvae collected in Costa Rica. Details of the methods and rearing records may be found at <http://janzen.sas.upenn.edu> and in Janzen (2000, in press), Schauf

and Janzen (2001), Janzen et al. (2003), and Burns and Janzen (2001).

Acronyms used are: INBio = Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica; USNM = National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; BMNH = The Natural History Museum, London, UK. Voucher numbers associated with each reared adult are expressed as, for example, “99-SRNP-4547”; full details of the voucher record and associated images may be obtained at <http://janzen.sas.upenn.edu>.

TENTHREDINIDAE

This is a large family in the Neotropics, with about 32 genera and over 300 species. Four of the six Neotropical subfamilies are known from Costa Rica, the largest being

the Selandriinae and Blennocampinae. Only a few species of the other two, Nematinae (Smith 2003a) and Allantinae (Smith 2003b), occur there. The subfamilies may be distinguished with the keys in Smith (1995, 2003a). All Tenthredinidae in Costa Rica have 9-segmented, filiform or slightly compressed antennae.

SELANDRIINAE

This subfamily is recognized by its distinctive wing venation; most have vein 2A+3A complete, lack the anal crossvein, and have vein Rs+M distinctly curved near Sc+R in the forewing. It is the largest subfamily of Tenthredinidae in the Neotropics, and probably 60–70 species in nine genera occur in Costa Rica. Food plants are known for very few of them. Most extra-tropical members of this subfamily have ferns and grasses as food plants.

Adiaclema Enderlein

About 30 species of *Adiaclema* occur from southern Mexico to northern Argentina. The genus is distinguished by the absence of the anal crossvein in the forewing (a characteristic of the subfamily) and simple mandibles, a trait not possessed by other Neotropical Selandriinae. All other Neotropical selandriines have one or more subapical teeth on one or both mandibles. Types of all described species have been examined by DRS except for several that cannot be located, and it was determined that the following species reared in Costa Rica represents a new species. This is the first food plant record for the genus.

Adiaclema chigiyae Smith, new species

(Figs. 1, 8, 15, 16, 27, 32, 33, 37–39)

Female.—Length, 8.0–8.5 mm. Antenna black. Head black with clypeus, labrum, and maxillary and labial palpi white. Thorax orange. Abdomen orange with apical three segments and sheath black. Legs orange with foretarsal segments 3–4 slightly infusate; midfemur with a narrow black

ring at apex; midtarsus black; apical $\frac{2}{3}$ of hind tibia black with basal $\frac{1}{3}$ white; hind tarsus black. Forewing yellow with apex beyond stigma black; costa, subcosta, stigma, and veins yellow in yellow area; veins black in black apex.

Antennal length $2.1\times$ head width; length of 3rd segment $1.3\times$ length of 4th segment; segments beyond third gradually decreasing in length (Fig. 8). Eyes large and converging below; lower interocular distance $0.8\times$ eye length; upper interocular distance slightly greater than eye length (Fig. 15). Head from above strongly narrowing behind eyes; postocellar area $1.2\times$ broader than long; distances between hind ocelli, hind ocellus and eye, and hind ocellus and posterior margin of head as 6:12:10 (Fig. 16). Malar space linear; clypeus with anterior margin slightly convex; labrum about $2\times$ broader than long with anterior margin truncate. Hind basitarsus subequal in length to length of remaining tarsal segments combined. Hind wing with anal cell sessile. Tarsal claw with long inner tooth slightly shorter than outer tooth and without basal lobe (Fig. 37). Sheath short and rounded at apex in lateral view; in dorsal view slightly broader at center (Fig. 32). Lancet (Fig. 27) short, triangular, with about 9 serrulae; protuberances laterally on annuli 2–10, becoming more spinelike toward apex.

Male.—Length, 7.1–7.5 mm. Color similar to that of female except mesoprescutum blackish at center and nearly all hind tibia black with white only at extreme base. Tarsal claw with long, slender outer tooth and minute inner tooth (Fig. 38). Genitalia (Fig. 39) with harpe elongate and rounded at apex; parapenis narrow, tapering to small rounded apex; apex of penis valve about as long as broad, rounded at apex, with long dorsal lobe.

Holotype.—Female, labeled "Voucher: D. H. Janzen & W. Hallwachs, caterpillar (Lepidoptera) database, Area de Conservacion Guanacaste, Costa Rica. <http://>

janzen.sas.upenn.edu, 99-SRNP.9777." Deposited at INBio.

Paratypes.—COSTA RICA: All labeled as holotype except for voucher codes: 99-SRNP-9757 (1 ♀); 99-SRNP-10267 (1 ♂); 99-SRNP-10269 (1 ♀); 99-SRNP-10273 (1 ♀); 99-SRNP-10285 (1 ♀); 99-SRNP-10288 (1 ♂); 99-SRNP-10297 (1 ♀); 99-SRNP-10305 (1 ♀); 99-SRNP-10314 (1 ♀); 99-SRNP-10334 (1 ♂); 99-SRNP-10348 (1 ♀); Guanacaste Province, Santa Rosa National Park, D. H. Janzen, 24-VIII-14-IX-1985, Malaise trap SE-6-C (1 ♀). Deposited at INBio and USNM.

Etymology.—This species is named in honor of Chigiy Binell in recognition of her great enthusiasm for the ACG and support for the Rincon Rainforest.

Food plant and biology.—Larvae (Fig. 1) feed on moss, *Entodontopsis leucostega* (Brid.) W. R. Buck & Ireland (Stereophyllaceae). In the second month of the rainy season (late June to early July), the penultimate and last instar larvae were encountered feeding solitarily day and night while fully exposed on the rough surface of moss patches on logs and stumps in the ACG dry forest. They were not encountered in the first two decades of the caterpillar inventory because it did not occur to us to search shady, wet patches of moss.

The prepupal larva chews into the surface of rotten bark or wood, hollows out a smooth-walled ovoid chamber in which to pupate, and closes the entrance hole with wood or bark chips glued together. There is no sign of a silken cocoon in the chamber. The adult emerges 40–60 days after the cocooning chamber is constructed (average 47 days, $n = 12$) in the ACG rainy season climate. There was no evidence of pupal dormancy, but this does not exclude the possibility that the prepupae or pupae late in the rainy season pass the six month dry season dormant in the cocoon chamber. No parasitoids were produced from 135 wild-caught penultimate and last-instar larvae.

Remarks.—Of the Neotropical *Adiaclima*

species, only a few have the combination of yellow wings with a black apex, black head, entirely orange thorax, and orange abdomen with the apical segments black. This color is similar to *Adiaclima tetricum* (Konow) described from "Peru (Pozuzo)" (type examined), but *A. tetricum* differs by having the supraclypeal area and area around antennal bases white, has much longer antennae (length nearly three times the head width), has a long, narrow ovipositor sheath (with valvula 3 about two times longer than broad), has the lower interocular distance about $0.9\times$ the eye length, and is generally larger, being about 10 mm in length. *Adiaclima blandulum* (Enderlein) (type not located) described from Ecuador is also similar, but has most of the face above the antennae white.

In all other *Adiaclima* species examined, the tarsal claws of the female and male are similar with a long inner tooth and without a basal lobe (Fig. 37). It is most unusual for the male tarsal claws to differ so much from those of the female (Figs. 37, 38).

BLENNOCAMPINAE

There are about 150 species in 14 genera of Blennocampinae in the Neotropical Region and 25–30 species in five genera in Costa Rica, most of which are in the large genus *Waldheimia*. The subfamily is distinguished by its wing venation, with veins M and 1m-cu parallel, veins M and Rs+M meeting Sc+R at the same point, and the anal cell petiolate with the basal section of vein 2A+3A absent. One species, *Metapedias subcoerulea* (Cameron) has been reared from *Conostegia xalapensis* D. Don (Melastomataceae) (Smith 1995). Species of the genus *Periclista* Konow are found at high elevations in Costa Rica and may feed on *Quercus* sp. (Fagaceae), as do the North American counterparts.

Waldheimia Brullé

Nearly 100 species of *Waldheimia* are known with about ten in Costa Rica, and

the genus is widely distributed from southwestern United States to northern Argentina. Characteristics of the genus include the reduced apical four antennal segments, straight forewing vein $2A+3A$, and the bifid tarsal claws with the inner tooth usually broader and longer than the outer tooth and with a basal lobe. Three species have been reared in ACG.

***Waldheimia fascipennis* (Norton)**
(Fig. 2)

Discussion.—This is one of the few species of *Waldheimia* that have the forewings broadly black at both the base and apex and yellow in the center. The head, thorax, and abdomen are orange with the interocellar area, apical three abdominal segments, and sheath black. The coxae, trochanters, and femora are orange, the tibiae are white at the bases with the apical half to two-thirds black, the basitarsi are white with a narrow black apical ring, and the remaining tarsal segments are black. The male is unknown.

Distribution.—Costa Rica (Guanacaste); Mexico (Campeche, Chiapas); El Salvador. In addition to the reared specimens, the following from Costa Rica also have been examined: Santa Rosa National Park, 14-IX-5-X-1985, Malaise trap H-3-0; Prov. Guanacaste, OTS Palo Verde Sta., 29 km W.S.W. Canas, 10°21'N, 85°21'W, 14-VII-1976.

Food plant and biology.—*Waldheimia fascipennis* larvae feed on leaves of *Cissus pseudosicyoides* Croat (Vitaceae) during the rainy season in ACG dry forest (two females: 90-SRNP-1141, 83-SRNP-1144). One record from the last month of the rainy season represents either a second or third rainy season generation. The bluish and pale yellow larvae feed side-by-side on the upper sides of the relatively horizontal mature leaves in groups of 1–5 (Fig. 2). They are currently indistinguishable in color pattern, shape, and behavior to those of *Waldheimia suturalis*, which have been reared from *Cissus rhombifolia* in the same

habitat. Numerous *Waldheimia* larvae feeding on both species of *Cissus* have not produced adults, and it may be that both species of *Waldheimia* feed on both species of *Cissus*.

The prepupal larva burrows down into the litter and pupates naked in a chamber with no silk cocoon. The adults emerged 13–14 days after the prepupa entered the soil ($n = 2$). While no dormancy was recorded in rainy season pupae, the prepupae may well pass the dry season dormant in the litter. A total of 36 *Waldheimia* (*W. fascipennis* and *W. suturalis*) wild-caught penultimate and last-instar larvae produced no parasitoids.

***Waldheimia interstitialis* (Cameron),
new combination**
(Fig. 3)

Discussion.—This species was described in the genus *Blennocampa* Hartig by Cameron (1883) and transferred to *Erythraspides* Ashmead by Smith (in Kimsey and Smith 1985), but *Erythraspides* and *Waldheimia* cannot be distinguished in the Neotropics. Formal generic synonymy will be presented later in another paper, and here we give the new combination.

The coloration is distinctive for both sexes of this species. The antennae are black with the scape and pedicel orange. The head, thorax, and abdomen are orange with the interocellar area and sheath black. The legs are orange, with the apex of the midfemur, the entire hind femur, the apical third to half of the mid- and hind tibiae, and the apical three tarsal segments of all legs black. The wings are yellow with the apex beyond the stigma black. Cell M is absent in the hind wing.

Distribution.—Costa Rica (Alajuela, Guanacaste, Heredia, San José), Mexico (Veracruz); Panama; Venezuela. Costa Rican specimens examined are as follows: Prov. Heredia, La Selva Biol. Sta., 3 km S Pto. Viejo, 10°26'N, 84°01'W, 6-VI-83, 27-IV-90, 17-I-91; Escazú, May 21, 24, 26, 27,



Figs. 1-4. Larvae. 1, *Adiaclenia chigiyae*. 2, *Waldheimia fascipennis*. 3, *W. interstitialis*. 4, *Aulacomerus daktus*.

1987; Alajuela, 700 m, Penas Blancas, IV-1987.

Food plant and biology.—*Hamelia patens* Jacq. (Rubiaceae) was recorded as the host plant by Kimsey and Smith (1985) who also described and illustrated the larva and gave the life history in Panama. One female was reared from the same species of food plant in Costa Rica under number 00-SRNP-9451 (three others on the same food plant died of disease) in the lower margin of ACG cloud forest at about 1000 m elevation (April, July). *Waldheimia interstitialis* spun no cocoon, pupated naked in the bottom of its rearing container, and used eight days from prepupa until eclosion. The red-headed, dark gray-blue-black solitary larvae with the underside yellow (Fig. 3) are quite similar to those of the other two species of *Waldheimia* described here, and, like the others, feed in

the daytime on the upper surface of the leaf.

In laboratory rearings, Kimsey and Smith (1985), reported that the larvae go into the soil and form a smooth-walled, silk-lined cocoon. There were ten days from cocoon formation to eclosion.

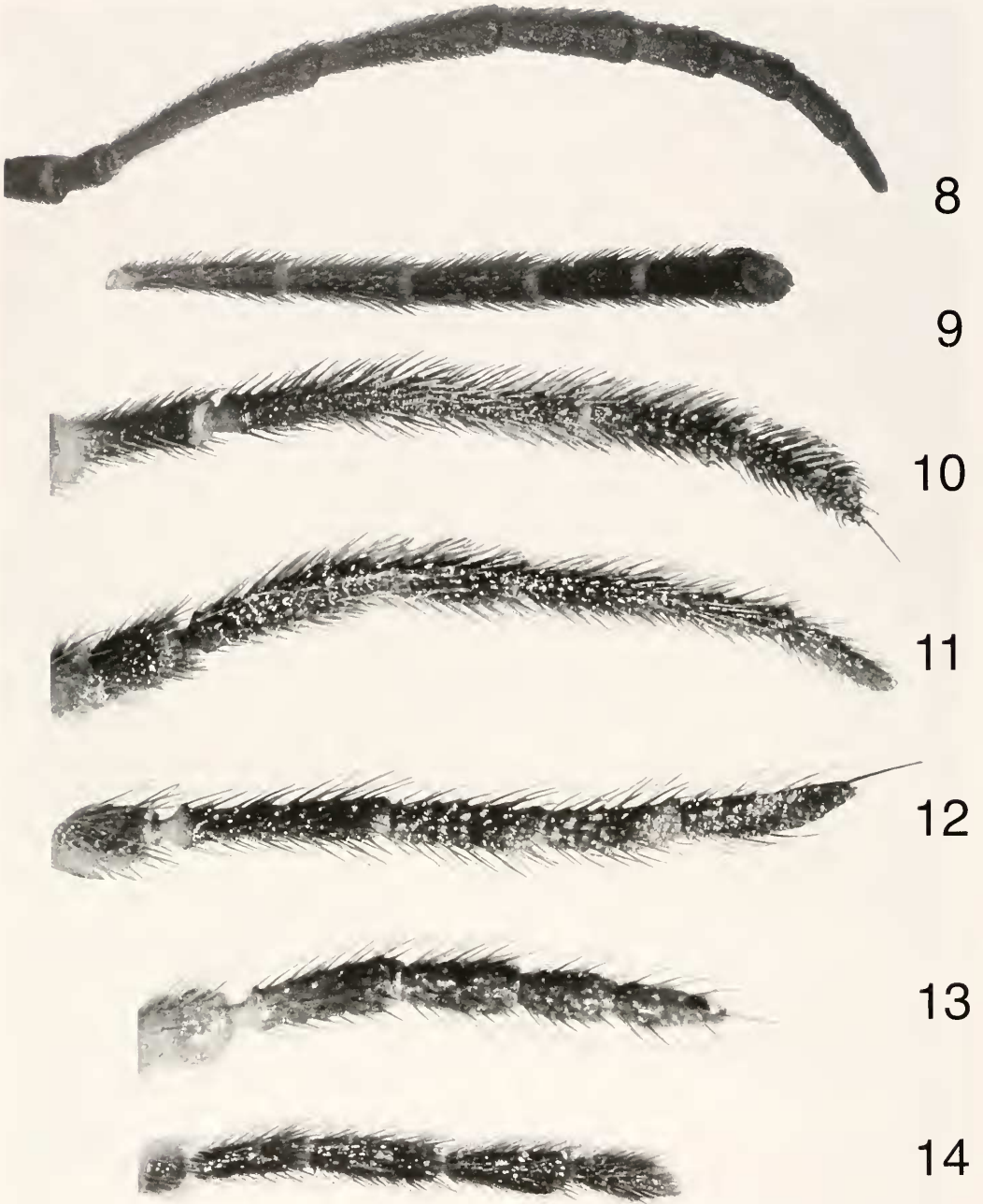
Waldheimia suturalis (Cameron)

Discussion.—Both sexes of this species are entirely black with the following parts of the thorax red: pronotum, tegulae, mesonotum, mesopleuron, and upper half of the metapleuron. The wings are uniformly, darkly infuscated. The female has cell M present in the hind wing, and the male has a peripheral vein in the hind wing.

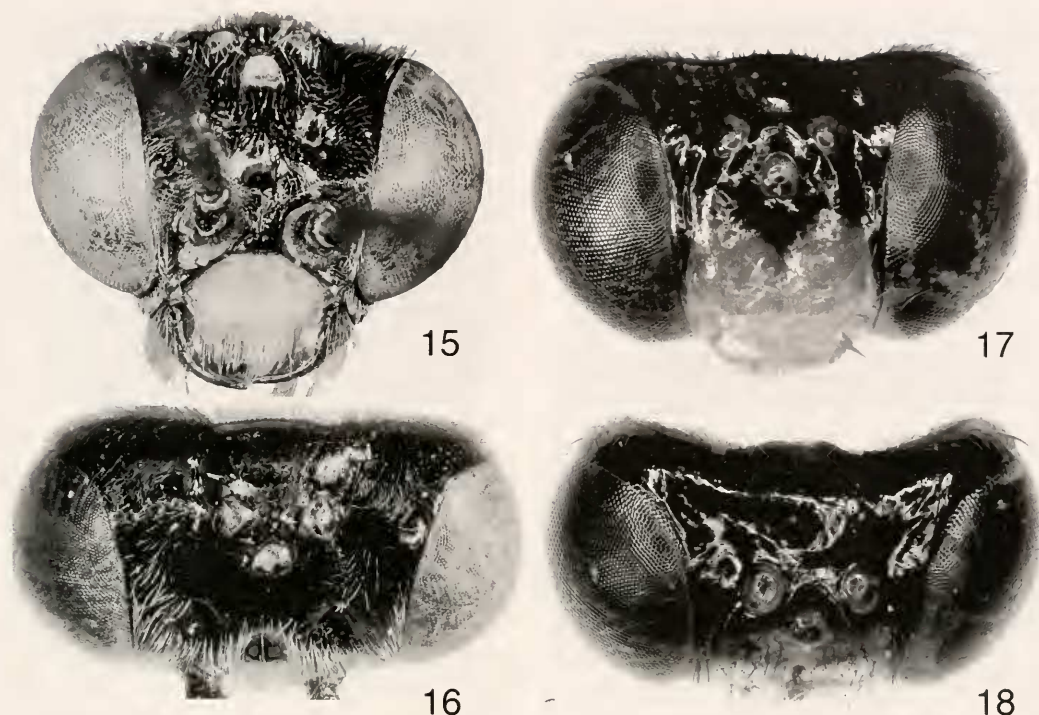
Distribution.—Costa Rica (Guanacaste, Heredia); Guatemala; Honduras; Mexico (Morelos, Veracruz). Specimens examined from Costa Rica other than those reared



Figs. 5-7. Larvae. 5, 6, *Anathulea bimaculata*. 7, *Acordulecera dashielli*.



Figs. 8-14. Antennae. 8, *Adiaclena chigiyae*. 9, *Aulacomerus daktus*, flagellum. 10, *Anathulca bimaculata*. 11, *Suwatnus nigriceps*. 12, *Acordulecera binelli*, pedicel and flagellum. 13, *A. liami*, pedicel and flagellum. 14, *A. dashielli*, pedicel and flagellum.



Figs. 15–18. Head. 15, *Adiaclium chigiyae*, front view. 16, *A. chigiyae*, dorsal view. 17, *Anathulca bimaculata*, front view. 18, *A. bimaculata*, dorsal view.

are as follows: Guanacaste Prov., OTS Palo Verde Sta., 29 km W.S.W. Canas, 10°21'N, 85°21'W, 5-VII-1976; Heredia Prov., La Selva Biol. Sta., 3 km S Pto. Viejo, 10°26'N, 84°01'W, 17-IV-1988.

Food plant and biology.—Three females were reared from larvae eating mature leaves of *Cissus rhombifolia* Vahl (Vitaceae) during the rainy season in ACG dry forest (83-SRNP-727, 98-SRNP-1831, and 98-SRNP-1833); two males were reared under numbers 98-SRNP-1832.1 and 98-SRNP-1832 from the same food plant species at the same time. The bluish and pale yellow larvae feed side-by-side on the upper sides of the relatively horizontal mature leaves in groups of one to five. They are currently indistinguishable in color pattern, shape, and behavior to those of *Waldheimia fascipennis*, which have been reared from *Cissus pseudosicyoides* in the same habitat. Numerous *Waldheimia* larvae feeding on both species of *Cissus* have not pro-

duced adults, and it may be that both species of *Waldheimia* feed on both species of *Cissus*.

The prepupal larva burrows down into the litter and pupates in a chamber with no silk cocoon. The adults emerged 56–102 days (average 74 days, $n = 5$) after the prepupa entered the soil. This long pupation period is strikingly different from that of *W. fascipennis*, and probably represents some kind of rainy season dormancy. As mentioned above, a total of 36 *Waldheimia* (*W. fascipennis* and *W. suturalis*) wild-caught penultimate and last instar larvae produced no parasitoids.

NEMATINAE

This is a large subfamily in the arctic, subarctic, and temperate regions of the Northern Hemisphere. The number of species decreases sharply to the south, and very few are known from the Neotropics (Smith 2003a). *Pristiphora*, the only genus

known in Costa Rica, is the largest tropical-extending genus, and occurs from Mexico south to southeastern Brazil. The subfamily is recognized by its distinctive forewing venation, with veins M and 1m-cu markedly divergent, vein M meeting Sc+R far basal to the point where Rs+M meets Sc+R, and the anal cell petiolate with the base of vein 2A+3A absent.

Pristiphora Latreille

More than 50 species are known in the Nearctic, but only nine are known from Mexico to southern Brazil, and three in Costa Rica, mostly from elevations above 1000 m. The Neotropical species are keyed and described in Smith (2003a).

Pristiphora auricauda Smith

Discussion.—The distinctive coloration of the female (antennae, thorax, and legs black, and abdomen a contrasting bright orange, except for black basal plates and black anterior margin of the second segment) distinguishes this species from other *Pristiphora* in Costa Rica. The male has the head, thorax, and legs mostly yellow orange, with most of the head and thorax dorsally and the tibiae and tarsi black. The abdomen is orange, as is that of the female. The female ovipositor and male genitalia are illustrated in Smith (2003a).

Distribution.—Costa Rica (Guanacaste). Other than the reared specimens from ACG, an additional Costa Rican record is from Est. Cacao, 1000–1400 m, Lado Sur-oeste del Volcan Cacao, Prov. Guan., II curso parataxon., Jun 1990.

Food plant and biology.—The larvae live solitarily in leaf rolls of mature leaves of *Prunus annularis* Koehne (Rosaceae). Fourteen females and seven males were reared from 60 leaf rolls collected from two trees in the lower edge of ACG cloud forest at about 1000 m elevation (00-SRNP-9074, -9075, -9077, -9100, -9107, -9112, -9114, -9121, -9122, -9123, -9124, -9125, -9126, -9127, -9128, -9130, -9131, -9132, -9133, -9134, -9135). Eleven to 30 days were used

between spinning the cocoon and eclosing (average 17 days, $n = 14$) during the relative warm weather of the dry season. There was no suggestion of dormancy. The cocoon is a rough dark brown shaggy cylinder spun directly on the surface of the green leaf in the rearing container, though in nature the larvae probably descend to the litter to spin their cocoons. No parasitoids were reared from 60 wild-caught larvae.

PERGIDAE

Neotropical Pergidae were treated by Smith (1990). Eight subfamilies, 32 genera, and 256 species were recognized. Some additional species have been described since, and it would not be surprising if the number of described species is eventually doubled. Five subfamilies, ten genera, and 40 or more species occur in Costa Rica (Smith 1995). Representatives of two subfamilies, Loboceratinae and Acordulecerinae, have been reared by the ACG caterpillar inventory project.

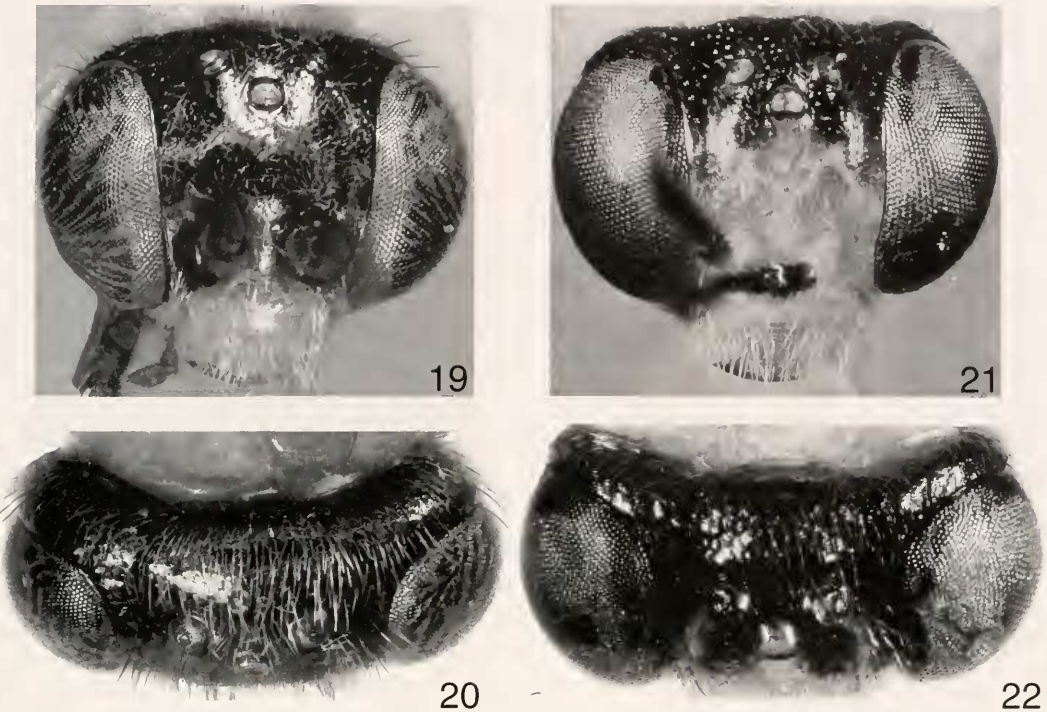
Food plants for other species include jelly fungus (*Auricularia* sp.) growing on rotting wood for *Decameria rufiventris* (Cameron) (Perreyiinae) (Smith 1995) and dried leaves for *Perreyia tropica* (Norton) (Perreyiinae), the larvae of which travel in groups on the ground (Flores et al. 2000).

LOBOCERATINAE

Three genera were treated by Smith (1990), but most species are in the genus *Aulacomerus*, which is the only Costa Rican genus. Two species were recorded from Costa Rica by Smith (1990), but more occur in the country. In Costa Rica, the subfamily is recognized by the 7-segmented, slightly clavate antennae with a large sensory pit on the apical segment, the midtibiae with a preapical spine, and the hind tibiae lacking a preapical spine.

Aulacomerus Spinola

This genus contains 22 species and occurs from Mexico to northern Argentina



Figs. 19–22. Head. 19, *Suwatnus nigriceps*, front view. 20, *S. nigriceps*, dorsal view. 21, *Acordulecera binelli*, front view. 22, *A. binelli*, dorsal view.

(Smith 1990). This is the first food plant record for a member of this genus.

Aulacomerus daktus Smith
(Figs. 4, 9)

Discussion.—We redescribe this species since it was originally known from only a few specimens. It is distinguished from other *Aulacomerus* species by the key in Smith (1990).

Description.—Length of female, 8.5–9.5 mm; male 7.0–8.0 mm. Antenna black with scape and pedicel orange yellow. Head orange with ocellar area and postocellar area black and with light black markings toward antenna and sometimes from lateral ocellus to eye. Antennal tubercles, supraclypeal area, clypeus, labrum, and mandible whitish. Thorax orange. Legs orange with about apical half of hind tibia and all hind tarsus black; fore- and midtarsi black except bases of basitarsi usually orange yellow. Abdomen

orange with center of 6th tergum and segments 7 to apex and sheath entirely black. Wings yellow with apex beyond apex of stigma black; veins and stigma yellow, veins black in black apices.

Antennal length 1.6× head width; large sensory area on apical segment; 3rd segment slightly longer than 4th segment (Fig. 9). Clypeus with slight central circular emargination. Eyes slightly converging below, lower interocular distance subequal to eye length, upper interocular distance 1.1× eye length. Head from above narrowing behind eyes. Postocellar area 1.6× broader than long. Distances between hind ocelli, hind ocellus and eye, and from hind ocellus to posterior margin of head as 10:11:16. Hind basitarsus 1.3× length of remaining tarsal segments combined. Inner hind tibial spur 0.8× length of hind basitarsus. Female lancet and sheath and male genitalia illustrated by Smith (1990, figs. 338, 345, 368).

Distribution.—Costa Rica (Guanacaste), Guatemala, Mexico (Chiapas). This is the first record for Costa Rica. An additional record, other than the ACG specimens is: Vicinity Estac Murcielago, 8 km SW Cuajniquil, Guanacaste Prov., 100 m, Jun 1989, GNP Biodiversity Survey 320300, 380200.

Food plant and biology.—Adults were reared from larvae eating mature leaves of *Mesechites trifida* (Jacq.) Müll. Arg. (Apo-cynaceae) [89-SRNP-500 (1♀); 92-SRNP-2490 (2♀, 1♂); 92-SRNP-3901 (3♀); 94-SRNP-9444 (5♀, 1♂); 94-SRNP-9529 (1♂)]. This species is occasionally encountered in groups of 3–7 greenish-black larvae (Fig. 4) feeding side-by-side on the upper or lower side of a single leaf of its herbaceous vine food plant during the mid to late rainy season in ACG dry forest. After consuming the entire leaf, the group moves up the stem to then consume the next leaf; in larval Lepidoptera, this has been interpreted as a strategy to remove the visual evidence of leaf damage from the view of avian predators (Heinrich 1993). As is commonplace with species of caterpillars feeding on latex-rich plants, the larvae cut the petiole of the leaf partly through before feeding on the blade, a behavior that reduces the flow of fresh latex from the bitten leaf blade (Dussourd and Eisner 1987). If the feeding group of penultimate or last-instar larvae is molested, they walk off in different directions on the food plant, but within an hour they regroup into the same feeding groups as before.

The penultimate instar larva molts into a non-feeding orange-purple morph that, in captivity, wanders on the foliage and litter for about 24 hours before spinning its smooth-walled, dark brown, ovoid cocoon in the litter. The adult emerges 12–16 days after cocoon spinning (average 14 days, $n = 14$). A total of 28 wild-caught late instar larvae produced no parasitoids.

ACORDULECERINAE

This is a large subfamily with many undescribed species. Smith's (1990) key cov-

ers ten genera, four of which occur in Costa Rica (Smith 1995). Many are very small, no more than 3–4 mm in length. The antennae are 6–9 segmented, mostly 6-segmented and filiform, the eyes are large, occupying much of the head, the mid- and hind tibiae each have a preapical spine, and the hind wing usually has the veins forming the base cells RS and M in a straight or almost straight line. *Acordulecera*, as defined by Smith (1990), is by far the largest genus in this subfamily.

Anathulea Malaise

Anathulea is characterized by the 6-segmented antenna, truncate clypeus which is two times or more broader than long, and the long pedicel which is one and one-half times or more longer than broad and nearly as long as the first flagellar segment (Fig. 10). Four species were listed by Smith (1990) from Guatemala and Brazil, but 10 to 20 species probably occur in the Neotropics. This is the first food plant record for a member of this genus.

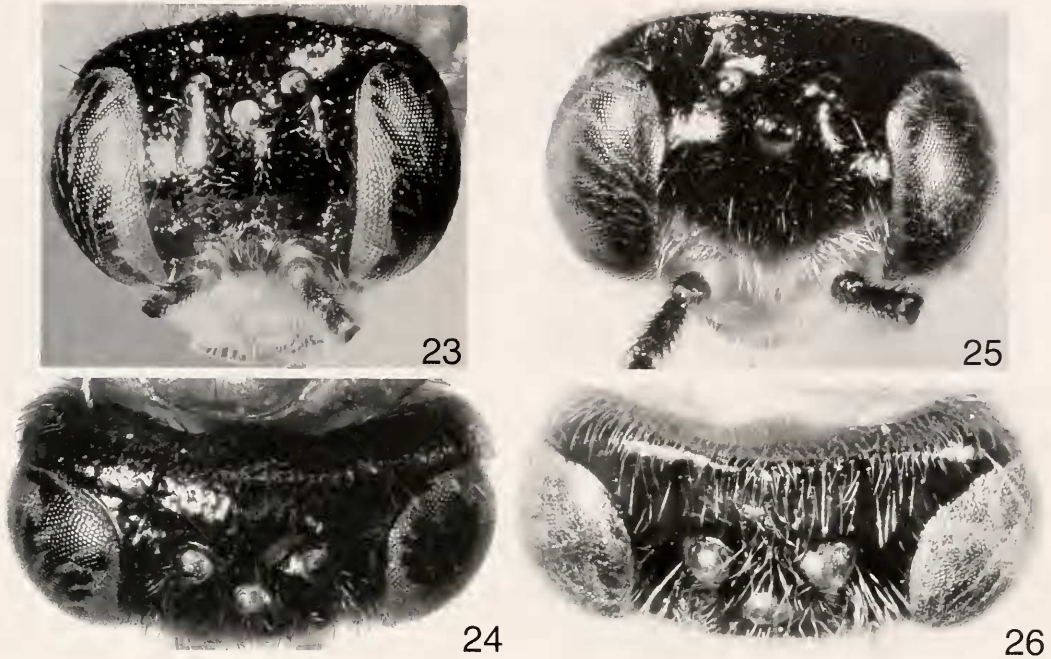
Anathulea bimaculata (Cameron)

(Figs. 5, 6, 10, 17, 18, 28, 33, 40)

Discussion.—This species has not been treated since its original description. It was described from Guatemala (Cameron 1883).

Female.—Length, 6.3–7.5 mm. Antenna black with scape and base of pedicel orange yellow. Head black, orange yellow from halfway between ocelli and antennae to clypeus and labrum. Thorax orange yellow with prescutum (except for sides) and lateral lobes (except for depressed lateral areas) black. Legs orange with apical 4 tarsal segments black. Abdomen orange with segments 7 or 8 to apex black. Forewing yellow, apex beyond apex of stigma black; veins and stigma yellow, veins black in black apex.

Antennal length $1.4\times$ head width; pedicel $2.7\times$ longer than broad and $0.6\times$ length of 3rd segment, 3rd segment $1.5\times$ length of 4th segment; long seta at apex of



Figs. 23–26. Head. 23, *A. liami*, front view. 24, *A. liami*, dorsal view. 25, *A. dashielli*, front view. 26, *A. dashielli*, dorsal view.

apical segment (Fig. 10). Eyes large and strongly converging below, lower interocular distance $0.6\times$ eye length, upper interocular distance $0.9\times$ eye length (Fig. 17). Head from above strongly narrowing behind eyes; postocellar area $2.1\times$ broader than long; distances between hind ocelli, hind ocellus to eye, and hind ocellus to hind margin of head as 7:6:8 (Fig. 18). Hind basitarsus $1.2\times$ longer than length of remaining tarsal segments combined; inner hind tibial spur $0.6\times$ length of hind basitarsus; hind tarsal segments 2–4 each as broad as long. Sheath (Fig. 33) long, length subequal to length of hind tibia; without scopae, in dorsal view broad, rounded to acute apex. Lancet (Fig. 28) with about 32 serrulae, broad at base and tapering to apex, with numerous, closely set annuli slanted toward apex dorsally.

Male.—Length, 4.8–6.0 mm. Similar to female except mesoprescutum mostly orange and costa and subcosta of forewing more brownish. Genitalia (Fig. 40) with harpe round, slightly broader than long,

with long hairs; parapenis acute on meson; penis valve rounded ventrally, slightly concave dorsally, without spines.

Distribution.—Costa Rica (Guanacaste), Guatemala, Panama. These are the first records for Costa Rica and Panama. In addition to the rearings from ACG, specimens from Costa Rica have been examined from the following: Est. Maritza, 600 m, Lado oeste Volcan Orosi, Prov. Guan., II curso Parataxonomos, Ago 1990, L-N-326900, 373000; Guanacaste, W side Volcan Orosi, Est. Maritza, 600 m, 1988; Guanacaste NP, riparian, Oct. 20, 1977; Guanacaste Prov., Santa Rosa National Park, D. H. Janzen, 11-V-1-VI-85, Malaise trap BH-9-0, 13-VII-3-VIII-85, Malaise trap BH-12-C, 16-XI-7-XII-85, Malaise trap BH-10-C, 24-VIII-14-IX-84, Malaise trap SE-5-0.

Food plant and biology.—The larvae feed on the new shoot tips and shoot epidermis of *Hippocratea volubilis* L. (Hippocrateaceae) in the ACG dry forest (20♀ and 10♂: 01-SRNP-15925 to -15983, 01-SRNP-15940

to -15945, 01-SRNP-15947 to -15949, 01-SRNP-15951 to -15953, and 01-SRNP-16144 to -16146). The gray-brown early instar larvae occur in a tight cluster of 8–12 larvae arrayed on the lengthening shoot tips (Figs. 5, 6) of vine shoots growing horizontally (in search of insulated areas) across the forest floor in the deep shade of old-growth forest in the second month (July) of the rainy season. In this position, the larvae are extremely cryptic, appearing to be a cluster of small leaf buds at the shoot tip end (possibly an example of collective mimicry; Pasteur 1982). The larvae collectively eat the very tender shoot tip back down the stem until reaching the woody stem, and then continue back down the stem eating off the green tender outer epidermis, leaving the dead beige woody branch end (Fig. 6). These later instar larvae, arranged 3–6 around the stem look like dead tissue peeling back from the stem. There is no sign of larvae in the canopy tens of meters above where the mature woody vines have their crowns in the full sun.

The prepupal larvae drop or crawl off into the litter and spin solitary beige-brown ovoid cocoons among the dead leaves. There are 14–20 days between cocoon spinning and adult eclosion (average 16 days, $n = 31$). About 100 wild-caught larvae of all ages produced no parasitoids.

Swatnus Smith

This genus is very similar to *Acordulecera*, but has 7-segmented antennae (Fig. 11). One species was treated by Smith (1990).

Swatnus nigriceps (Cameron) (Figs. 11, 19, 20)

Discussion.—We redescribe this species because the original description is not adequate. It was described from "Mexico" by Cameron (1883).

Female.—Length, 4.2–4.7 mm. Antenna black. Head black with clypeus and mouthparts yellow orange and apical

maxillary palpal segment blackish; apex of mandible reddish brown. Thorax orange; tegula black; upper part of mesopleuron may be blackish. Legs orange white with tarsi and outer surfaces of tibiae black. Abdomen orange ventrally and laterally, black above with central longitudinal orange stripe; sheath black. Wings lightly, uniformly infuscated; veins and stigma black.

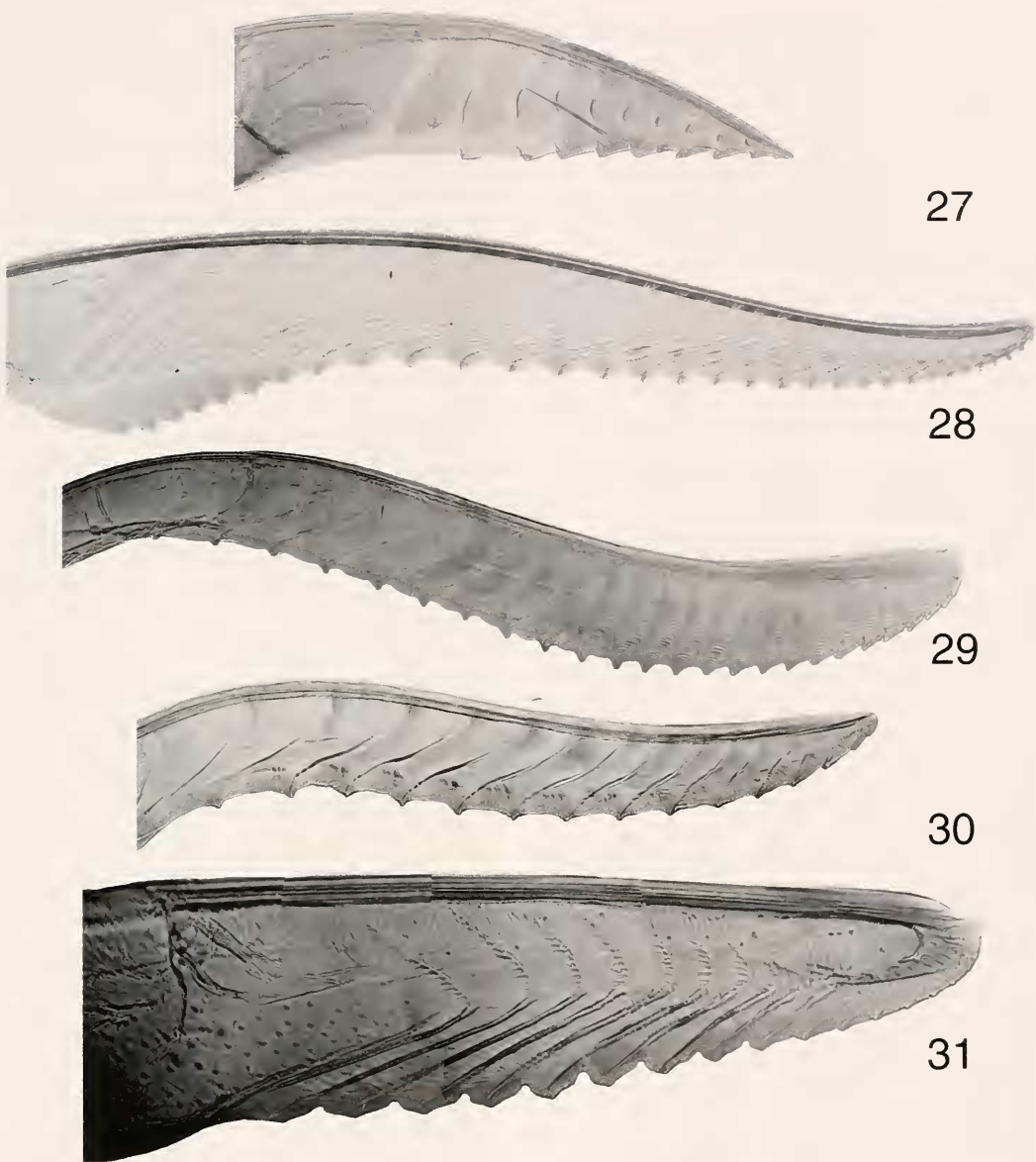
Antennal length $1.1\times$ head width; 3rd segment $0.8\times$ length of 4th segment, flagellar segments each longer than broad; apical segment without a long seta (Fig. 11). Eyes strongly converging below, lower interocular distance $0.8\times$ eye length; upper interocular distance subequal to eye length (Fig. 19). Head from above strongly narrowing behind eyes; postocellar area $2.0\times$ broader than long; distances between hind ocelli, hind ocellus and eye, and hind ocellus and posterior margin of head as 11:8:19 (Fig. 20). Hind basitarsus $1.3\times$ longer than length of remaining tarsal segments combined. Sheath with slender, posteriorly projecting scopae; sheath and lancet illustrated by Smith (1990, figs. 415, 420).

Male.—Length, 4.3 mm. Black, with head similar to that of female; thorax black with pronotum brownish; legs white with bases of coxae, tarsi, and stripe on outer surface of mid- and hind femora black; abdomen black with paired brownish spots on terga 2–4. Genitalia illustrated by Smith (1988, fig. 418).

Food plant and biology.—Three females and one male were reared from larvae feeding on mature leaves of *Psidium guajava* L. (Myrtaceae) (99-SRNP-3146) on the ACG interface of dry forest with rainforest. The white, solitary, globular silk cocoons were spun among the litter in the rearing container. Six wild-caught larvae produced no parasitoids.

Acordulecera Say

This large genus occurs from southern Canada to Argentina. Smith (1990) did not give a species key but listed the 45 de-



Figs. 27–31. Female lancets. 27, *Adiaclema chigiyae*. 28, *Anathulea bimaculata*. 29, *Acordulecera binelli*. 30, *A. liani*. 31, *A. dashielli*.

scribed species from south of the United States. There are numerous undescribed species, and the size of the genus may exceed 200 species. Most species are small, 4–6 mm long, and all have 6-segmented antennae (Figs. 12–14). Probably more than 20 species occur in Costa Rica, most of which are undescribed. All types of the

Neotropical species have been examined by DRS; the following three species do not agree with the three described species from Mexico and Central America, and they are not the same as any of the species described from South America. Because of the new host plant and life history information, they are described here.

Acordulecera binelli Smith, new species

(Figs. 12, 21, 22, 29, 34)

Female.—Length, 5.5 mm. Antenna black with scape orange yellow. Head black, yellow orange below line just in front of front ocellus (Fig. 21); mouthparts yellow orange; apex of mandible reddish brown. Thorax yellow orange with pronotum white and mesonotal front and lateral lobes, tegula, and metanotum black. Legs orange with apical three tarsal segments black. Abdomen and sheath orange. Wings uniformly hyaline; forewing with apical half of costa and stigma, except for black extreme apex, yellow orange, other veins black.

Antennal length $1.1\times$ head width and $2.1\times$ distance between eyes above; 3rd segment $1.4\times$ length of 4th segment; apical segment slightly longer than 4th segment and $4.1\times$ longer than broad; apical segment with long apical seta; hairs long, mostly longer than width of segments (Fig. 12). Head with scattered punctures. Eyes converging below, lower interocular distance about $0.7\times$ eye length; upper interocular distance about $0.9\times$ eye length (Fig. 21). Head from above strongly narrowing behind eyes; postocellar area about $2.0\times$ broader than long; distances between hind ocelli, hind ocellus and eye, and hind ocellus and posterior margin of head as 7:7:10 (Fig. 22). Distance between antennae subequal to distance between antenna and eye. Hind basitarsus $1.4\times$ length of remaining tarsal segments combined. Sheath (Fig. 34) with stout, short lateral scopae, in lateral view scopae rounded and about equal to length of inner portion of sheath, in dorsal view with long hairs slightly curved inward. Lancet (Fig. 29) long, with about 24 rounded serrulae, serrulae at apex flatter; annuli on apical half with hairs, annuli on basal half with no or only short, indistinct hairs.

Male.—Unknown.

Holotype.—Female, labeled "Voucher: D. H. Janzen & W. Hallwachs caterpillar

(Lepidoptera) database, Area de Conservación Guanacaste, Costa Rica, <http://janzen.sas.upenn.edu/>, "00-SRNP-9024." Deposited at INBio.

Etymology.—This species is named in honor of Rich Binell in recognition of his great enthusiasm for the ACG, love of its roads, and support for the Rincon Rainforest.

Food plant and biology.—Three larvae were found feeding side-by-side on mature leaves of *Posoqueria latifolia* (Rudge) Roem. & Schult. (Rubiaceae) in lower ACG cloud forest at about 1000 m elevation. The larvae are yellowish at the rear and thorax, with a black head. Two died of disease and one spun a broadly ovoid, pinkish-beige cocoon directly on the surface of a leaf in the rearing container. The adult emerged 26 days later.

Remarks.—The color and presence of a seta on the apical antennal segment is quite similar to *Acordulecera lituratus* (Kownow) described from Amapá, Brazil. In *A. lituratus*, the abdomen is black above, and the apical seta of the apical antennal segment is extremely long, nearly as long as the apical antennal segment. Characters of the antenna, head, sheath, and lancet should be examined and compared with the illustrations for identification of this species.

Acordulecera liami Smith, new species

(Figs. 13, 23, 24, 30, 35, 41)

Female.—Length, 4.1–4.4 mm. Antenna black, scape and pedicel more whitish. Head black with clypeus and mouthparts yellow orange; apex of mandible reddish brown. Thorax orange. Legs yellow orange with apical 2–3 segments of fore- and midtarsi and entire hind tarsus black. Abdomen orange, dorsally black with median, longitudinal orange stripe; sheath black. Wings hyaline; veins and stigma black.

Antennal length $0.6\times$ head width and $1.2\times$ distance between eyes from above; 3rd segment $1.4\times$ length of 4th segment;

apical segment subequal in length to 4th segment and $2.8\times$ longer than broad at its greatest width; long seta at apex of apical segment; hairs equal to or longer than width of segments (Fig. 13). Head shining with scattered punctures. Eyes converging below, lower interocular distance $0.8\times$ eye length; upper interocular distance subequal to eye length (Fig. 23). Head from above strongly narrowing behind eyes; postocellar area $2.0\times$ broader than long; distances between hind ocelli, hind ocellus and eye, and hind ocellus and posterior margin of head as 10:7:10 (Fig. 24). Distance between antennae $1.7\times$ distance between antenna and eye. Hind basitarsus subequal in length of length of remaining tarsal segments combined. Sheath (Fig. 35) with short, stout scopae, in lateral view scopa narrow and rounded, shorter than inner portion of sheath, in dorsal view with slightly incurved hairs. Lancet (Fig. 30) with about 14 pointed serrulae; annuli strongly slanted apically toward dorsum and lacking hairs or armature.

Male.—Length, 3.1 mm. Similar in color and structure to female except antenna with only scape whitish; thorax black with posterior margin of pronotum yellow orange with small spot at center of mesoscutellum orange; abdomen black with basal sterna pale orange and median longitudinal orange stripe only on anterior half of dorsum. Genitalia (Fig. 41) with harpes nearly rectangular, parapenis rounded mesally, and penis valve nearly straight ventrally, slightly concave dorsally, narrowly rounded at apex, and without spines.

Holotype.—Female, labeled "Voucher: D. H. Janzen & W. Hallwachs caterpillar (Lepidoptera) database, Area de Conservación Guanacaste, Costa Rica, <http://janzen.sas.upenn.edu>, 98-SRNP-1825." Deposited in INBio.

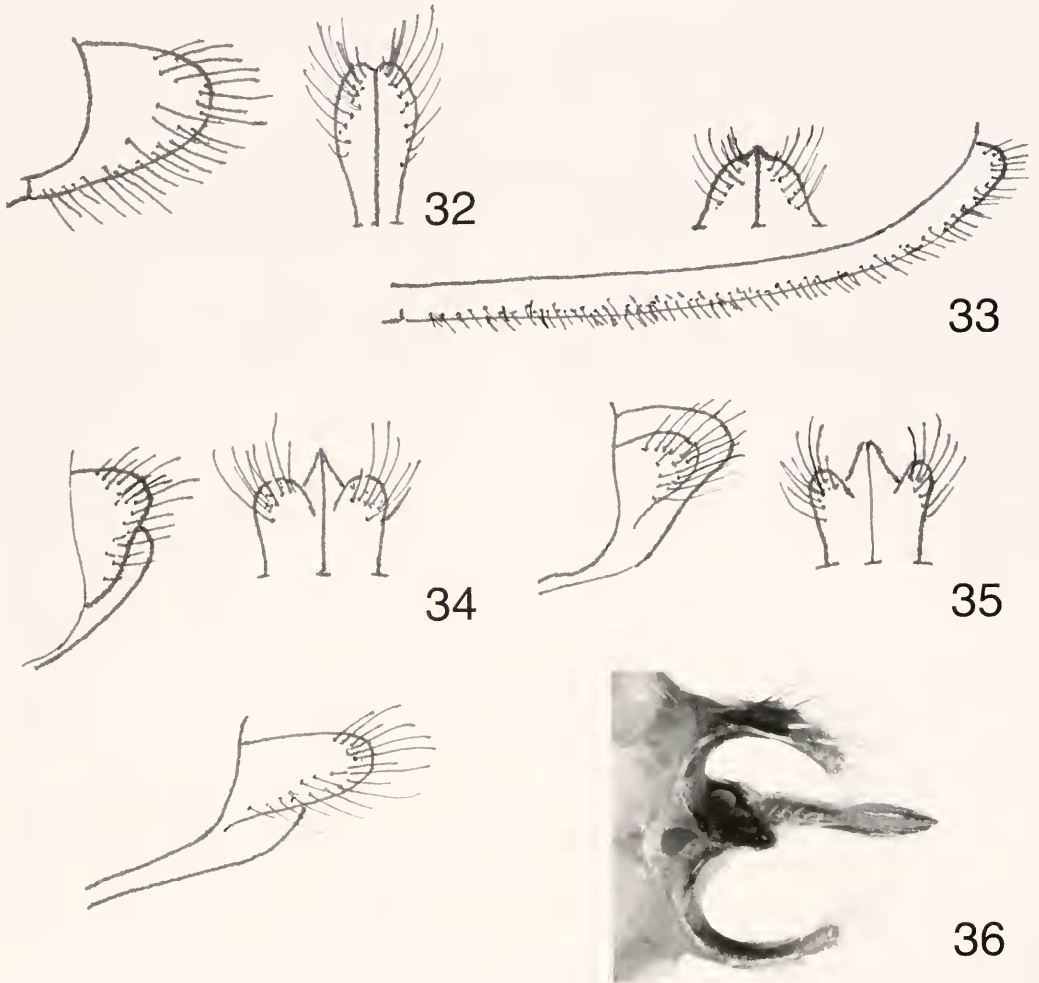
Paratypes.—COSTA RICA: Same labels as holotype, except numbers, 98-SRNP-1823 (1♀), 98-SRNP-1826 (1♀), 98-SRNP-1827 (1♀), 98-SRNP-1824 (1♂); Costa Rica,

Guanacaste Province, Santa Rosa National Park, D. H. Janzen, 11-V-1-VI-1985, Malaise trap SE-8-C (5♀), Malaise trap H-1-0 (1♀), Malaise trap SE-5-0 (1♀), Malaise trap H-2-C (1♀), Malaise trap SE-7-0 (3♀), Malaise trap SE-6-C (11♀), Malaise trap BH-9-0 (1♀); 1-22-VI-1985, Malaise trap SE-6-C (1♀). Deposited in INBio, USNM, BMNH.

Etymology.—This species is named in honor of Liam Binell in recognition of his great enthusiasm for the ACG, potential as crocodile bait, and support for the Rincon Rainforest.

Food plant and biology.—The light green larvae feed on the new and expanding leaves of the understory shrub *Erythroxylum havanense* Jacq. (Erythroxylaceae) in the first month of the rainy season in ACG dry forest. They feed solitarily, one on each of the small ovoid leaves, and perch along the margin so as to appear to be part of the leaf. In some years, such as 1992 and 1998, they were extremely abundant, nearly defoliating many of the food plant shrubs. The solitary beige to brown ovoid cocoons are spun among the litter. Only five days transpire between spinning and adult eclosion. No parasitoids were reared from hundreds of wild-caught larvae.

Remarks.—This species is close in color to *Acordulecera calceolatus* (Konow) described from Oyapock, Brazil, and *A. cervicatus* (Konow) described from Itaituba, Brazil, all sharing the presence of a long seta on the apical antennal segment. In *A. calceolatus*, the mesoprescutum and mesoscutellum are dark orange, the abdominal dorsum is black, the apical 2–3 tarsal segments are black, and the sheath has more slender, projecting lateral scopae. In *A. cervicatus*, the anterior half of the mesoprescutum, apical half of the mesoscutellum, and the metascutellum are black, the abdomen is orange with the apical two segments black, and the tibiae and tarsi are black. Identification of *A. liami* should be based on comparison of the specimens with the illustrations.



Figs. 32–36. Female sheaths, lateral and dorsal views. 32, *Adiaclema chigiyae*. 33, *Anathulea bimaculata*. 34, *Acordulecera binelli*. 35, *A. liami*. 36, *A. dashielli*.

Acordulecera dashielli Smith,
new species

(Figs. 7, 14, 25, 26, 31, 36, 42)

Female.—Length, 4.8–5.2 mm. Antenna black with scape yellow orange. Head black with area below line just above antennae and mouthparts yellow orange (Fig. 25); apex of mandible reddish brown. Thorax orange with tegula black; blackish area laterally on each mesonotal lateral lobe. Legs orange with tibiae and tarsi black. Abdomen orange with apical two terga and sheath black. Wings moderately

and uniformly infuscated; veins and stigma black.

Antennal length subequal to head width and $1.9\times$ distance between eyes from above; 3rd segment slightly shorter than 4th segment; apical segment $0.8\times$ length of 4th segment and $2.5\times$ longer than broad at its greatest width; apical segment without long seta at apex; hairs equal to or shorter than width of segments (Fig. 14). Head shining, nearly impunctate. Inner margin of eyes subparallel, hardly converging below, lower and upper inter-

ocular distances subequal to slightly shorter than eye length (Fig. 25). Head from above strongly narrowing behind eyes; postocellar area $2.1\times$ broader than long; distances between hind ocelli, hind ocellus and eye, and hind ocellus and posterior margin of head as 10:8:11 (Fig. 26). Distance between antennae $2.8\times$ distance between antenna and eye. Hind basitarsus $1.3\times$ longer than length of remaining tarsal segments combined. Sheath (Fig. 36) with long, narrow projecting scopae, in lateral view slender and rounded, much longer than inner portion of sheath; in dorsal view, scopae forcepslike, curving inward at apices. Lancet (Fig. 31) short, with about 14 serrulae, with slight dorso-apical notch at apex. Basal 8 serrulae broad and rounded and separated by narrow notch; serrulae beyond 8 small and becoming indistinct toward apex. Annuli strongly curved, ventral half without hairs, dorsal half with fine hairs.

Male.—Length, 3.5–4.2 mm. Similar to female except bases of tibiae paler and apical maxillary palpal segments blackish. Genitalia (Fig. 42) with harpe nearly triangular, lateral and apical margins rounded, inner margin straight; parapenis rounded mesally; penis valve elongate, rounded at apex, with ventral and lateral spines.

Holotype.—Female, labeled “Voucher: D. H. Janzen & W. Hallwachs caterpillar (Lepidoptera) database, Area de Conservación Guanacaste, Costa Rica, <http://janzen.sas.upenn.edu>, 96-SRNP-6815.” Deposited at INBio.

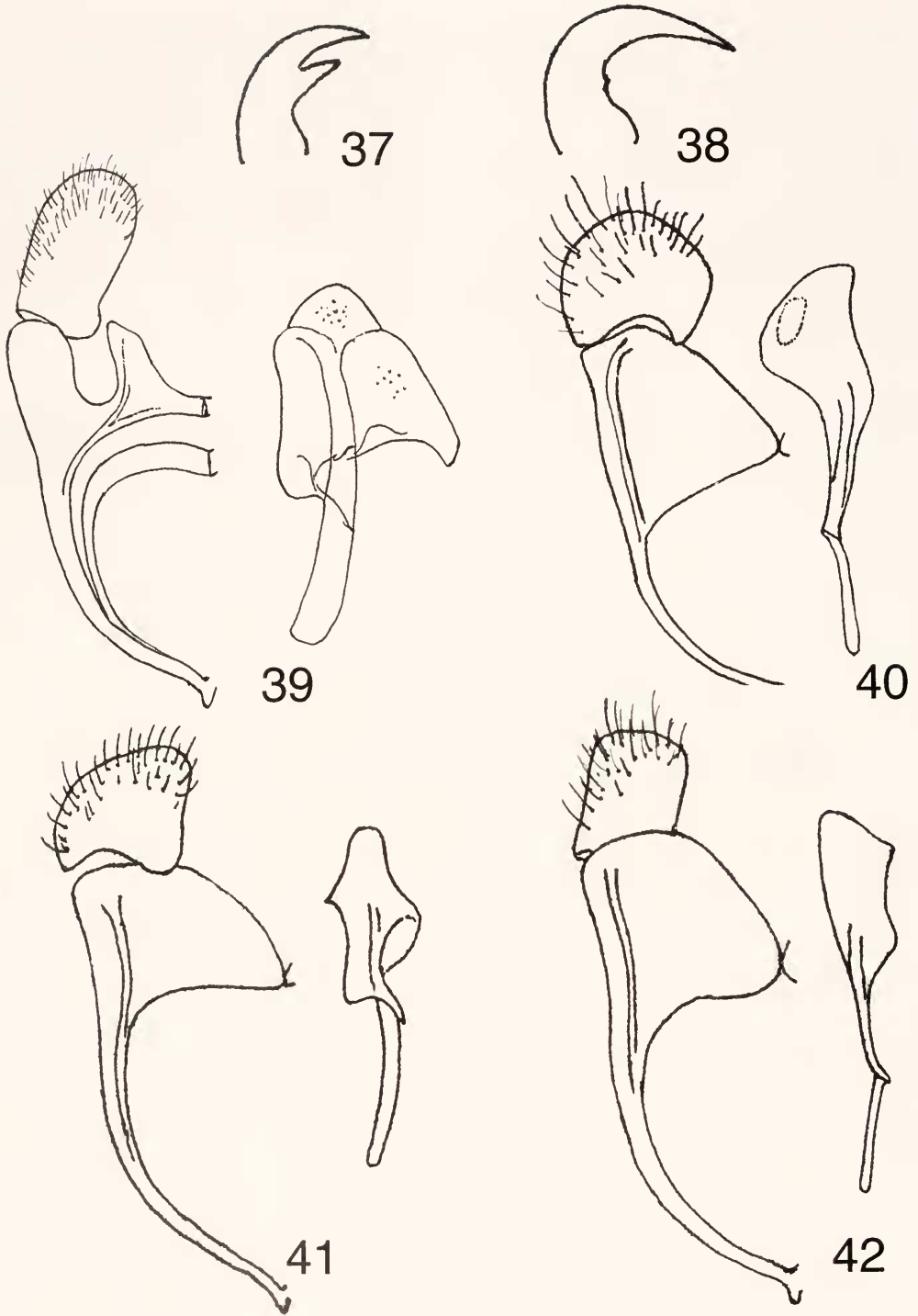
Paratypes.—COSTA RICA: Specimens labeled as above, all beginning with 96-SRNP-: 6811 (1♀); 6815 (1♀); 6821 (1♂); 6822 (1♂); 6824 (1♀); 6824.1 (1♀); 6825 (1♀); 6826 (1♀); 6829 (1♀); 6948 (1♀); 6948.1 (1♀); 6948.2 (1♀); 6948.3 (1♀); 6948.4 (1♀); 6948.5 (1♀); 6948.7 (1♀); 6948.8 (1♀); 6948.10 (1♀); 6948.11 (1♀); 6948.12 (1♀); 6948.13 (1♀); 6948.14 (1♀); 6948.15 (1♀); 6948.16 (1♀); 6948.17 (1♀); 6948.18 (1♀); 6948.19 (1♀); 6948.20 (1♀);

6948.21 (1♂); 6948.22 (1♂); 6948.23 (1♂); 6948.24 (1♀); 6948.25 (1♀); 6948.26 (1♀); 6948.27 (1♀); 6984.6 (1♀); 6984.9 (1♀); Guanacaste Province, Santa Rosa National Park, D. H. Janzen, 11-V-1-VII-1985, Malaise trap H-2-C (1♀), 11-V-1-VI-1985, Malaise trap SE-8-C (1♂), Malaise trap H-2-C (1♂), Malaise trap SE-7-0 (1♂), Malaise trap SE-6-C (3♂), 1-22-VI-1988, Malaise trap SE-8-C (1♀), 14-IX-5-X-1985, Malaise trap SE-7-0 (1♀), 22-VI-13-VII-1985, Malaise trap H-4-C (1♀). Deposited in INBio, USNM, BMNH.

Etymology.—This species is named in honor of Dashiell Binell in recognition of his great enthusiasm for the ACG, love of its beaches, and support for the Rincon Rainforest.

Food plant and biology.—The larvae feed on the newly expanded leaves of the wood vine *Arrabidaea patellifera* (Schltdl.) Sandwith (Bigoniaceae) in the ACG dry forest in the first month of the rainy season. The green and yellow larvae (Fig. 7) feed on the upper side of the nearly horizontal leaves. The early instars feed as a group, but, by the penultimate instars, they have separated to feed solitarily. The larvae drop to the ground to spin a very tough brown ovoid cocoon in the leaf litter. Between seven and 17 days lapsed between spinning and adult eclosion, but some larvae remained as dormant prepupae in their cocoons throughout the five remaining months of the rainy season and the entire six month dry season before dying, apparently because they did not get the right cue to eclose under laboratory conditions. This species has been found feeding on its common food plant only at the beginning of the rainy season, and it may well be univoltine in nature. No parasitoids were produced from 50 wild-caught larvae of all instars.

Remarks.—This species is very similar in coloration to *Acordulecera ricatus* (Konow) described from Peru, and both lack the seta on the apical antennal segment. However, *A. ricatus* has a hyaline forewing



Figs. 37-42. Tarsal claws and male genitalia, ventral view of left half of genital capsule on left, lateral view of penis valve on right. 37, Female tarsal claw of *Adiactema chigiyae*. 38, Male tarsal claw of *A. chigiyae*. 39, Male genitalia of *A. chigiyae*. 40, Male genitalia of *Anathulea bimaculata*. 41, Male genitalia of *Acordulecera liami*. 42, Male genitalia of *A. dashielli*.

with the base and apex of the wings black, whereas *A. dashielli* has uniformly lightly blackish wings. The sheath is distinctive for *A. dashielli*, but other characters need to be compared with the illustrations for determination.

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